

§10. Simultaneous Operation of Compact Cesium Hollow Cathodes in 1/3rd scale H-Source

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Plasma source for negative ion based NBI use the multi-filament type arc discharges. The filament lifetime restricts the maintenance free operation. It is expected that long lifetime or steady state operation can be done by applying compact Cesium Hollow Cathode, CHC. In this fiscal year, four upgraded CHCs which were developed by BINP were installed to generate stable plasmas in 1/3 scale H- ion source in LHD-NBI test-stand.1) Special power supply units, gas feeding systems and computer control systems were developed at NIFS.

Four CHCs were attached through the previous filament feed-through on sidewalls of the plasma source. Hydrogen and cesium were fed to each CHC independently. New CHC has equipped with auxiliary electrode to provide the discharge smooth and stable operation. Arc power was supplied by the maximum output power of 130V x 70A for 5sec every 90sec. Feedback control mode of the arc power supply was tested with CC-mode and CV-mode to make refinement of simultaneous operation. Hydrogen mixture with argon was tested for improvement of the discharge stability and for cesium consumption decrease.

As the 1st step experiment, the operation of two CHCs attached to the filament-ports of 1/6th scale source were studied. Two CHCs without auxiliary electrode was tested with CC-mode. Discharge was initiated by 1st CHC after then 2nd CHC was able to be initiated. In Fig.1, the discharge-current waveform for #1 CHC has constantly flat-topping, while it for #2 CHC looks

intermittent. After the shot, CHC was broken near the HC-aperture and oven was luck of the Cs supply. Open-loop voltage oscillation was considered to be large and there should possibly damage the control electronics and the insulator of the CHC.

As a 2nd step experiment we applied four upgraded CHCs, and the arc power supply with CV-mode. Stable discharge current- and voltage-waveform are obtained for 5sec (in Fig.2) with three CHCs. Discharge voltage ranges 30 ~ 40 V, and the current up to 70A is obtained successfully. Gas pressure in the multi-cusp chamber is 0.5~4mtorr. The 3rd CHC was broken due to overshoot of Cs because of trivially mis-wiring of the heating circuit. This cesium overshoot prevented the HV conditioning of the 1/3rd scale source in the initial test of H- ions extraction and acceleration under the luck of operation time before the LHD campaign. We proved successfully a simultaneous operation of three CHCs in 1/3rd scale multi-cusp plasma source.

Reference,
1)Belchenko,Yu, Oka,Y. et al, Rev.Sci.Instrum.vol.73, 940(2002)

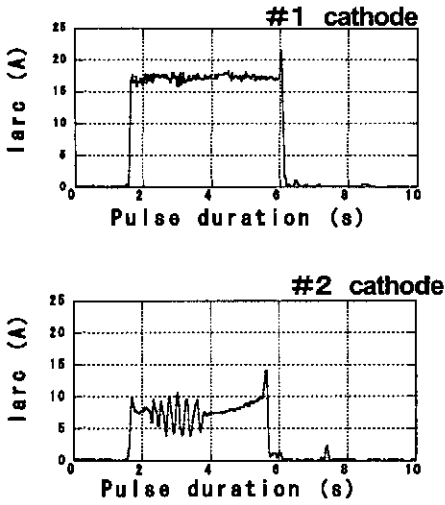


Fig.1. Discharge current waveform for two CHCs.

Fig.2 Discharge wave-
form for three upgraded-
CHC cathodes.

